A Generative Decision Support Architecture (GDSA)

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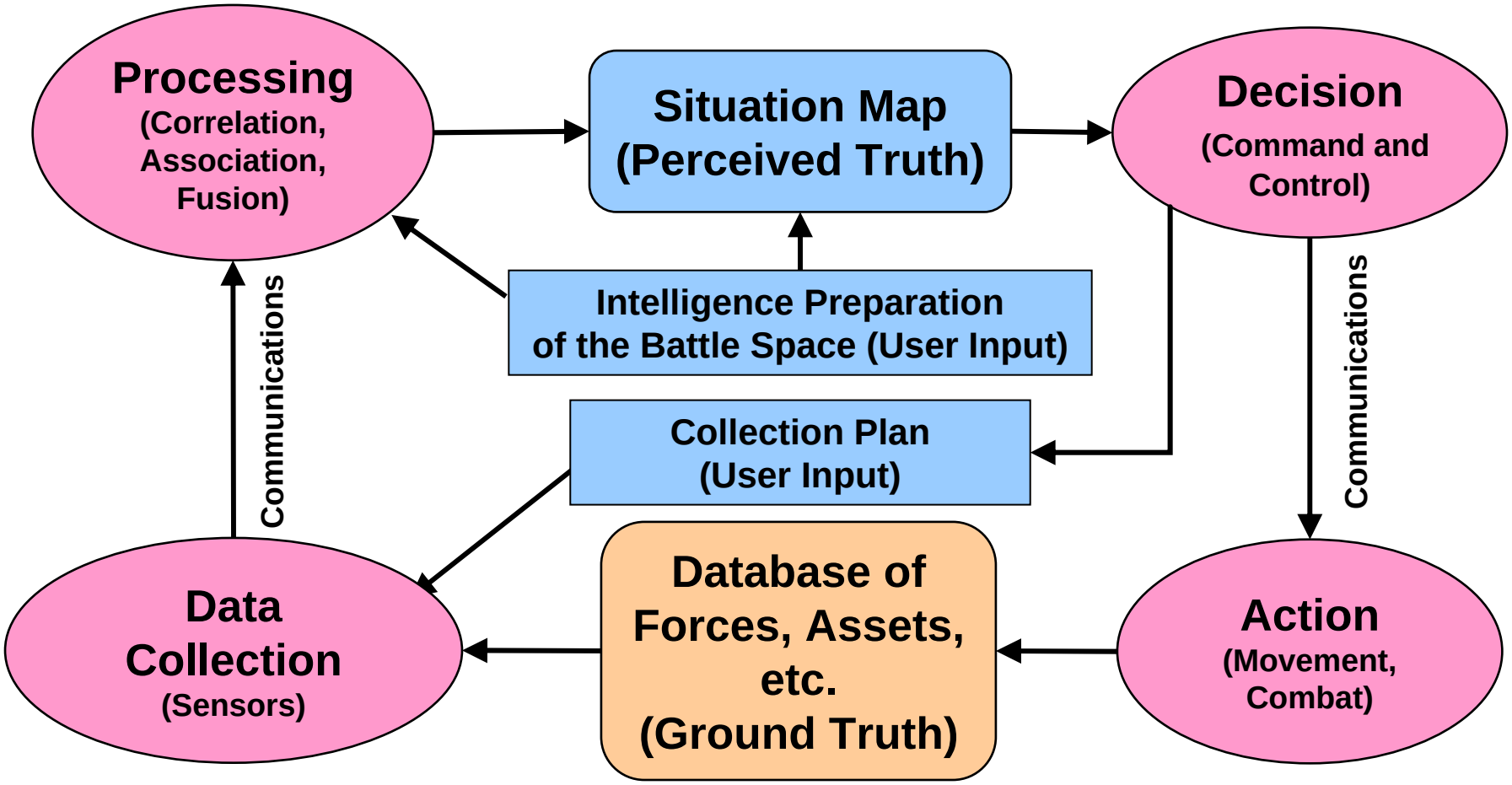
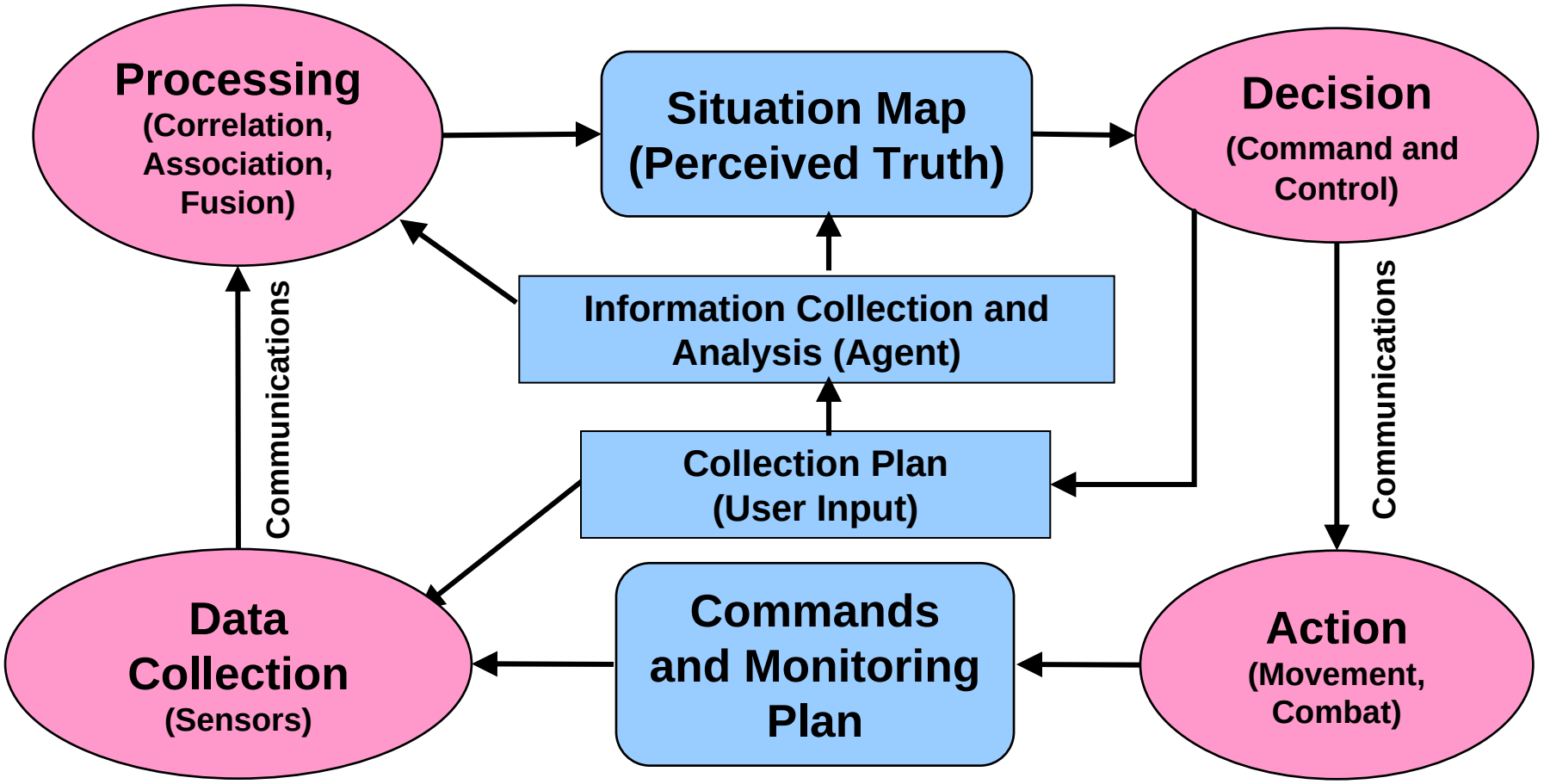
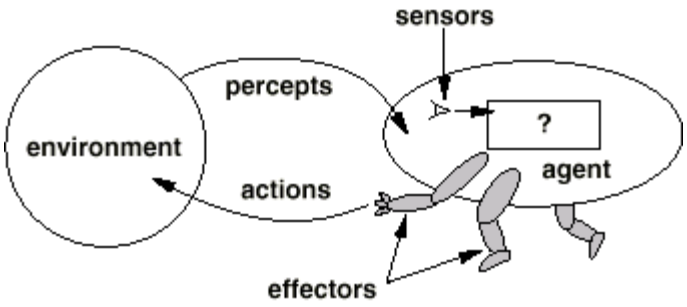
C4ISR Model


Processing
(Correlation, Association, Fusion)
Situation Map
(Perceived Truth)
Decision
(Command and Control)
Intelligence Preparation of the Battle Space (User Input)
Collection Plan
(User Input)
Communications
Communications
Data Collection
(Sensors)
Database of Forces, Assets, etc.
(Ground Truth)
Action
(Movement, Combat)

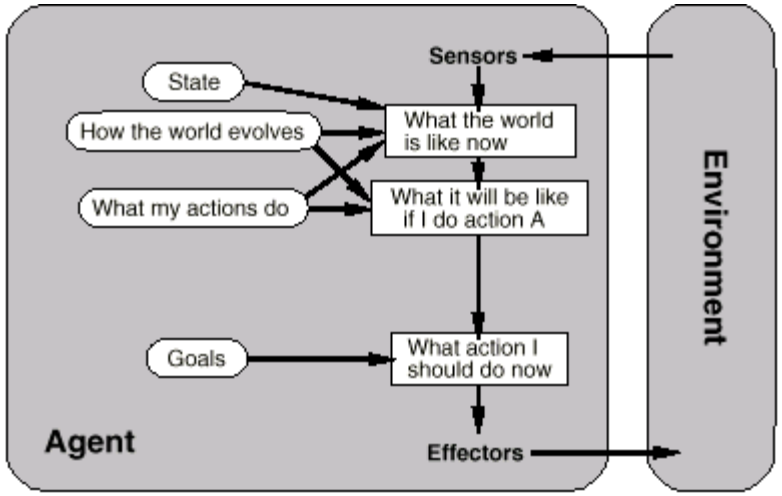
Decision Support Model

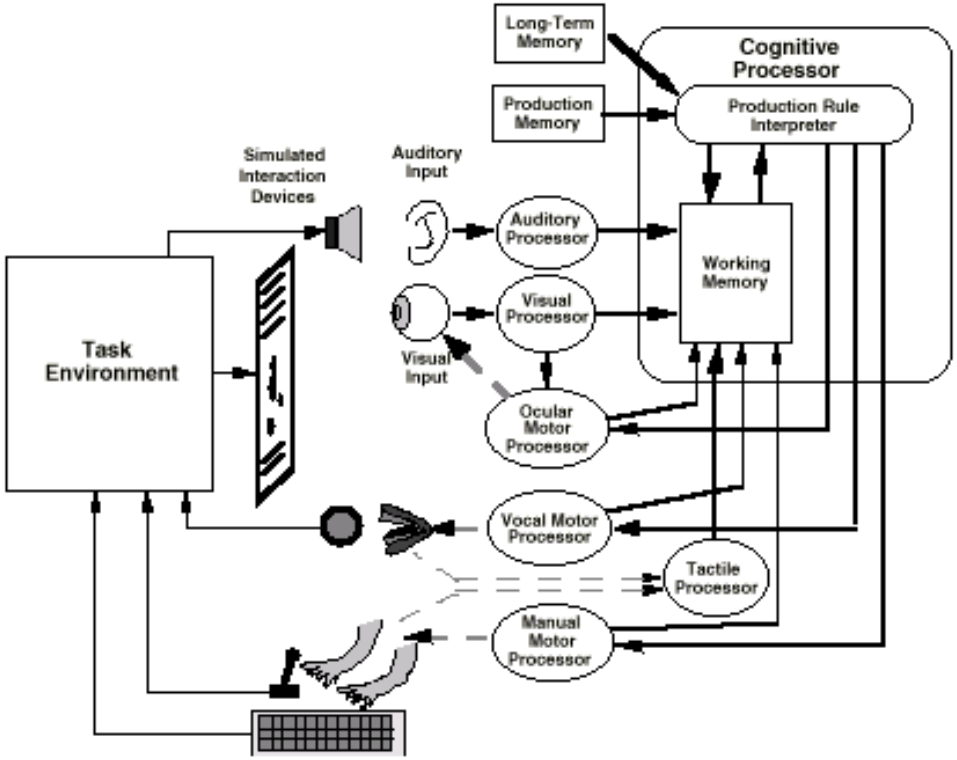


Agents



Russell and Norvig, Artificial Intelligence: A Modern Approach





Kieras and Meyer, "An Overview of the EPIC Architecture for Cognition and Performance with Application to Human-Computer Interaction"

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Objective

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- Develop an agent generation architecture for decision support applications.
  - Improve the tie between cognitive task analysis and software development.
  - Lessen the time necessary for developing decision support software.
  - Improve the quality of decision support software
  - Provide the flexibility necessary to support NCW
- Provide a method to evaluate an agents contribution to decision support.

Problem/Deficiency Being Addressed

- Decision support requirements change rapidly in the operational war-fighting environment.

- Our current process for developing decision support software cannot meet the needs of the move towards NCW. Even current demands are stressing our capabilities.

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Technical Approach

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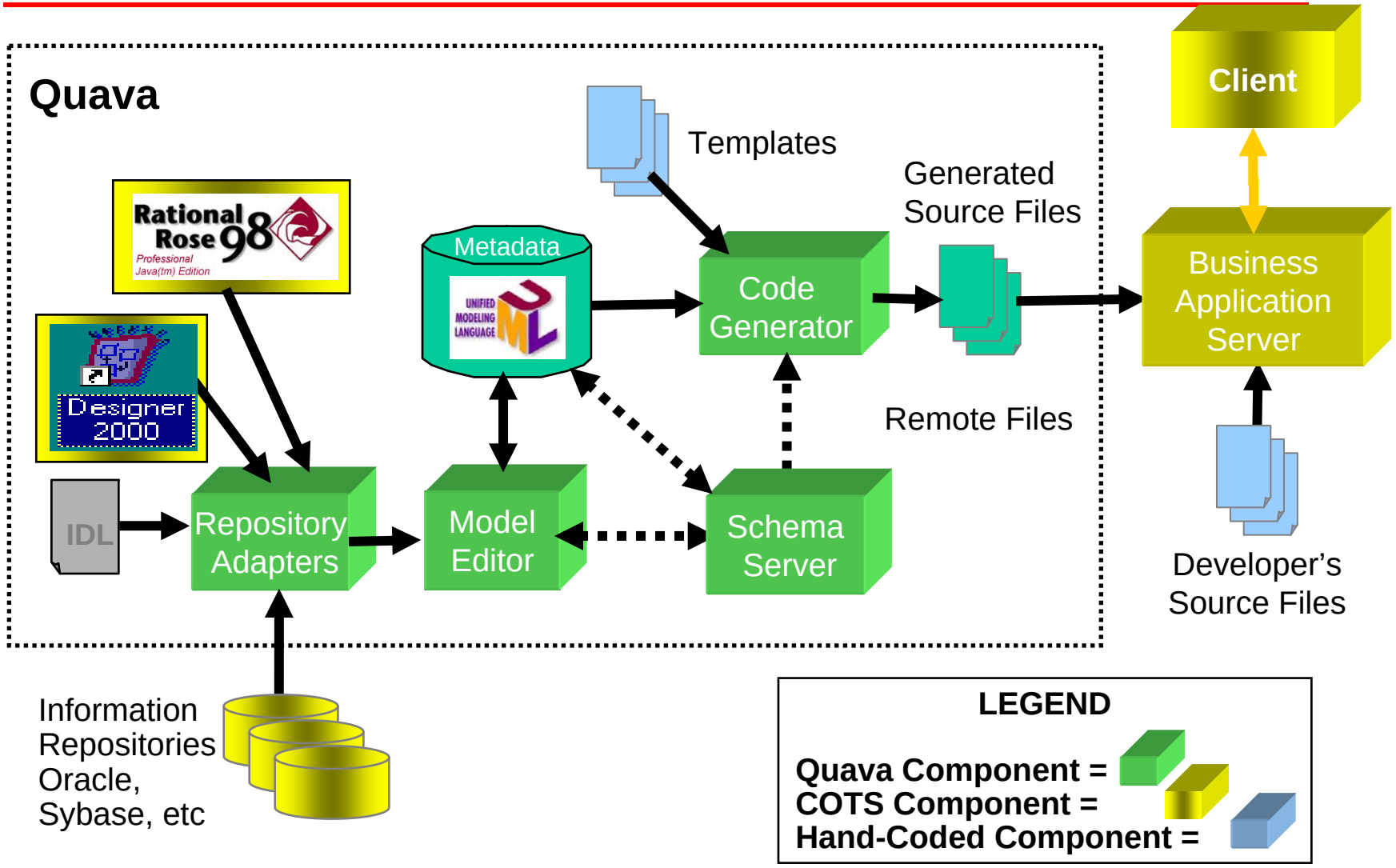
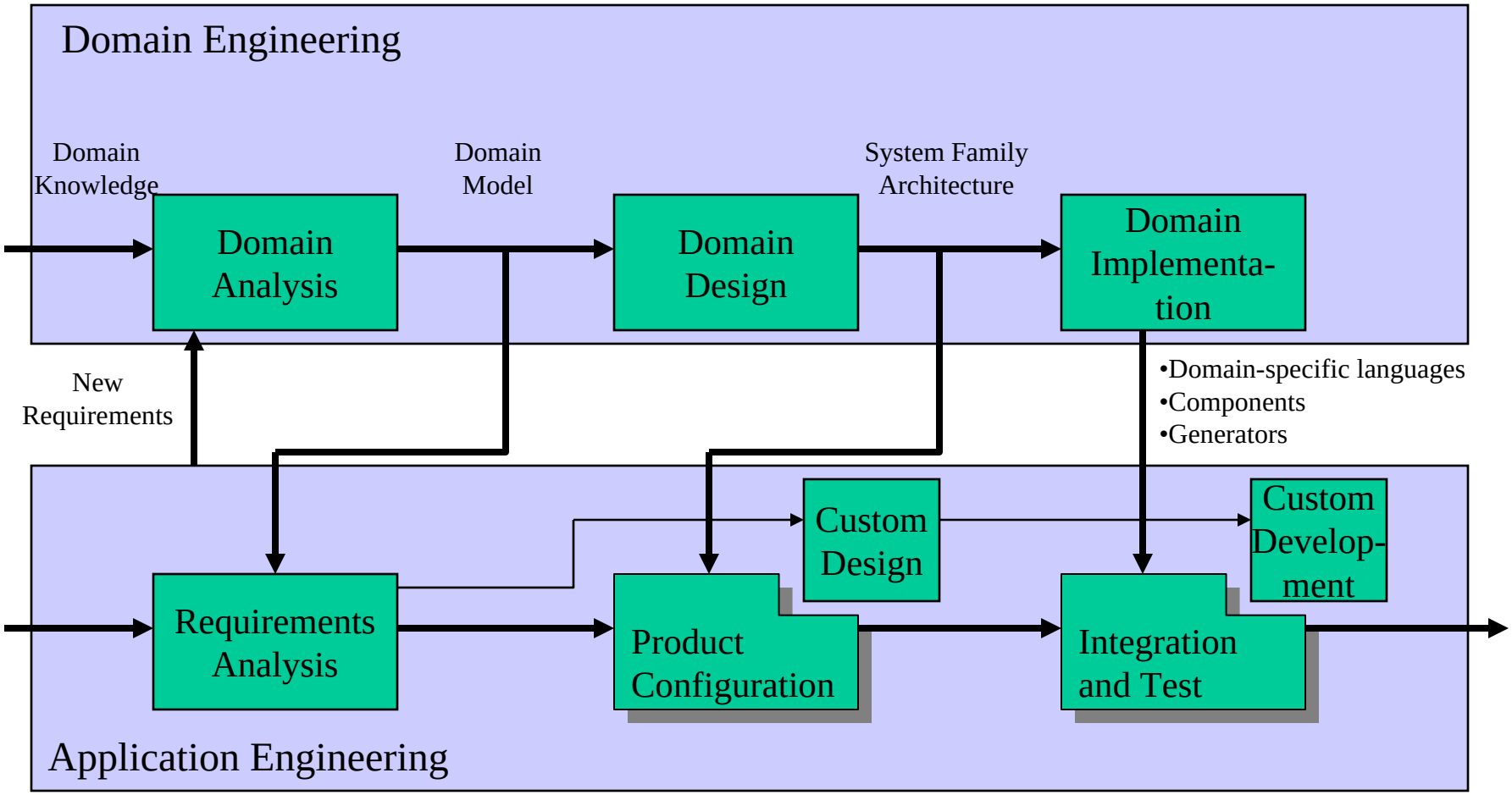
- Identification of cognitive task domain.
- Evaluate models of cognitive decision-making.
- Define a cognitive model that describes the environment.
- Translate the cognitive task model into a formal software model within a generative software architecture.
- Create a domain specific language (DSL).
- Domain design.
- Domain implementation.

Template Based Techniques



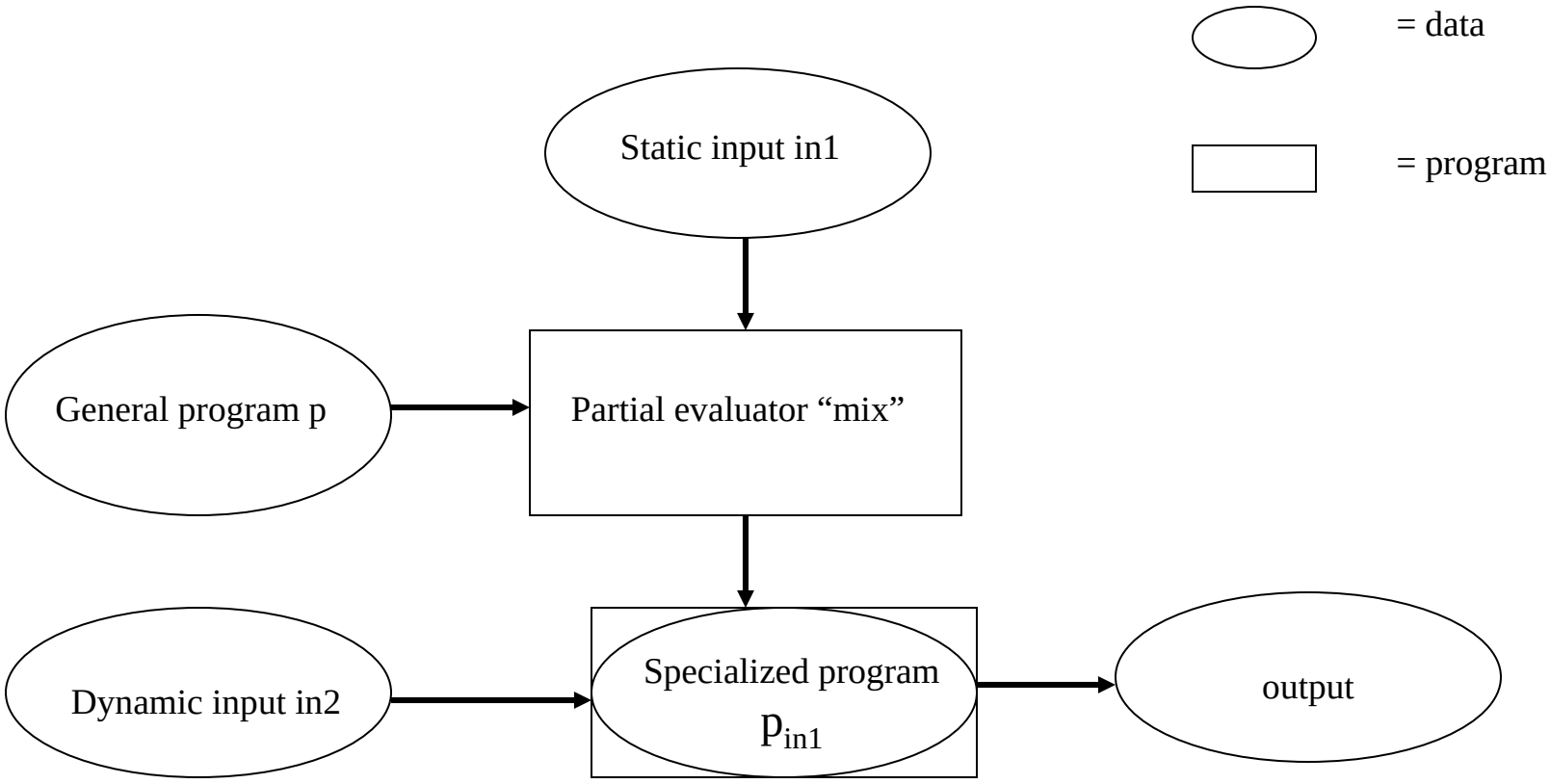
Ray and Farrar, "Object Model Code Generation for the Enterprise"

Generative Software Development



SEI, *Model-Based Software Engineering*

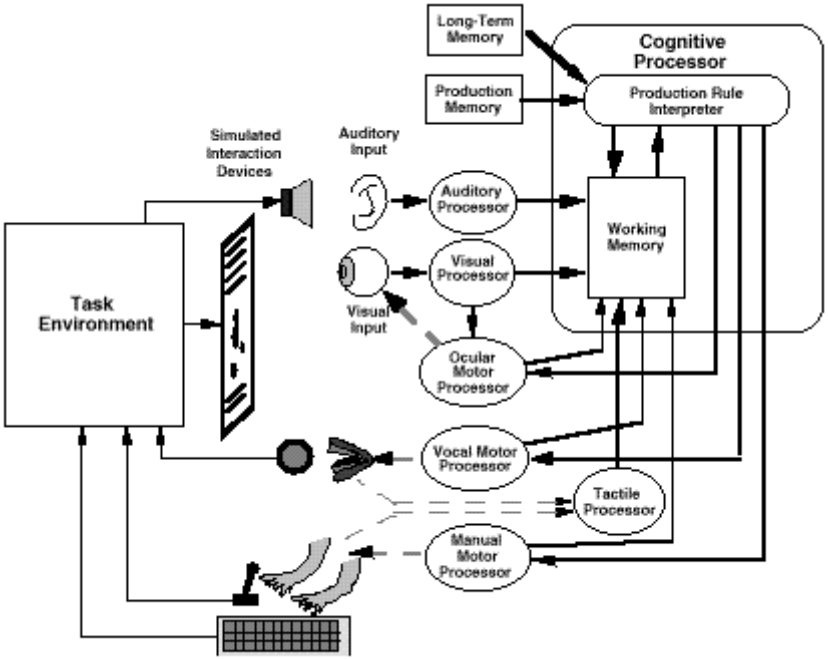
Partial Evaluation

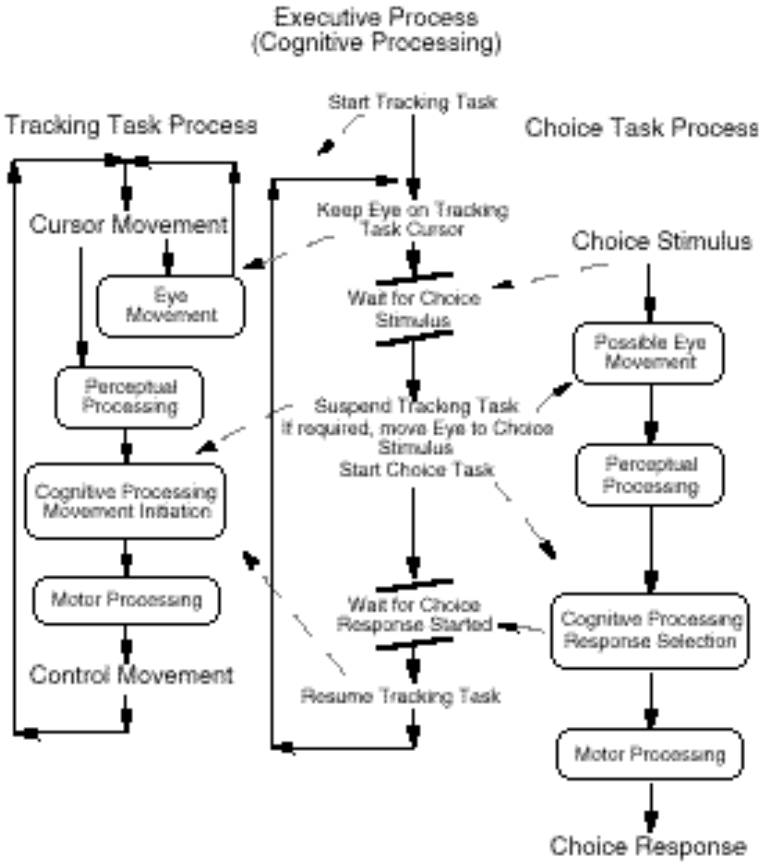


$$[\mathbf{p}]\ [in1, in2] = [p_{in1}]\ \ in2$$

Jones, “An Introduction to Partial Evaluation”

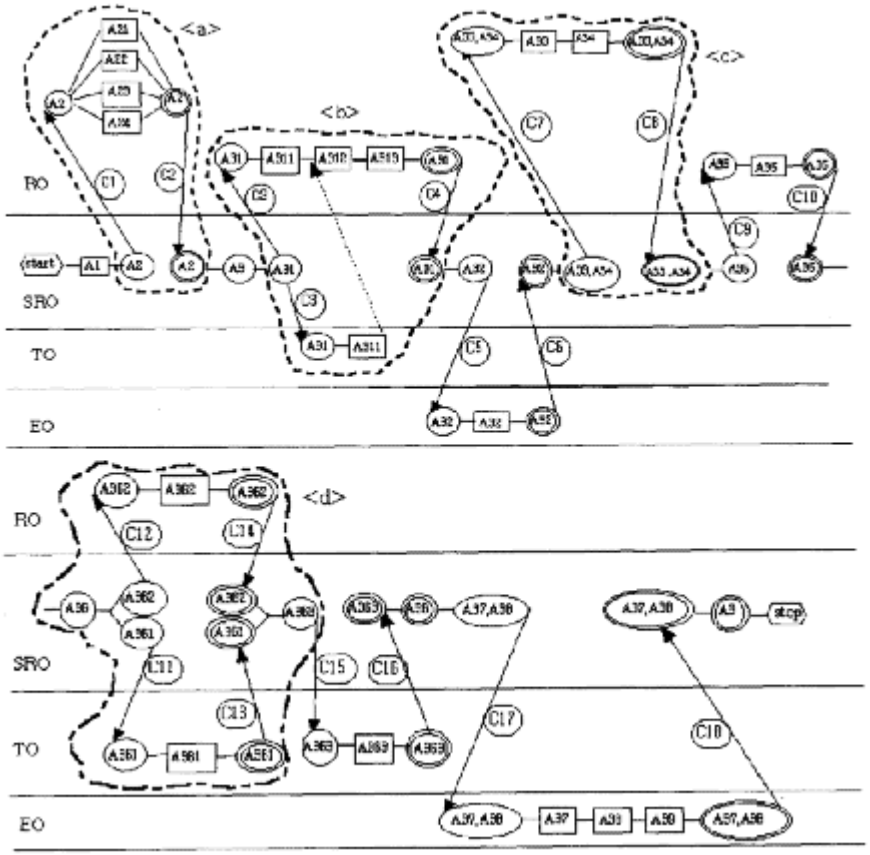
EPIC Model





Kieras and Meyer, "An Overview of the EPIC Architecture for Cognition and Performance with Application to Human-Computer Interaction"

GOMS Models



Method for goal: edit the document
  Step 1. Get next unit task information from marked-up manuscript.
  Step 2. Decide: If no more unit tasks, then return with goal accomplished.
  Step 3. Accomplish goal: move to the unit task location.
  Step 4. Accomplish goal: perform the unit task.
  Step 5. Goto 1.

Selection rule set for goal: perform the unit task
  If the task is moving text, then
      accomplish goal: move text.
  If the task is deletion, then
      accomplish goal: delete text.
  If the task is copying, then
      accomplish goal: copy text.
  ... etc. ...
  Return with goal accomplished.

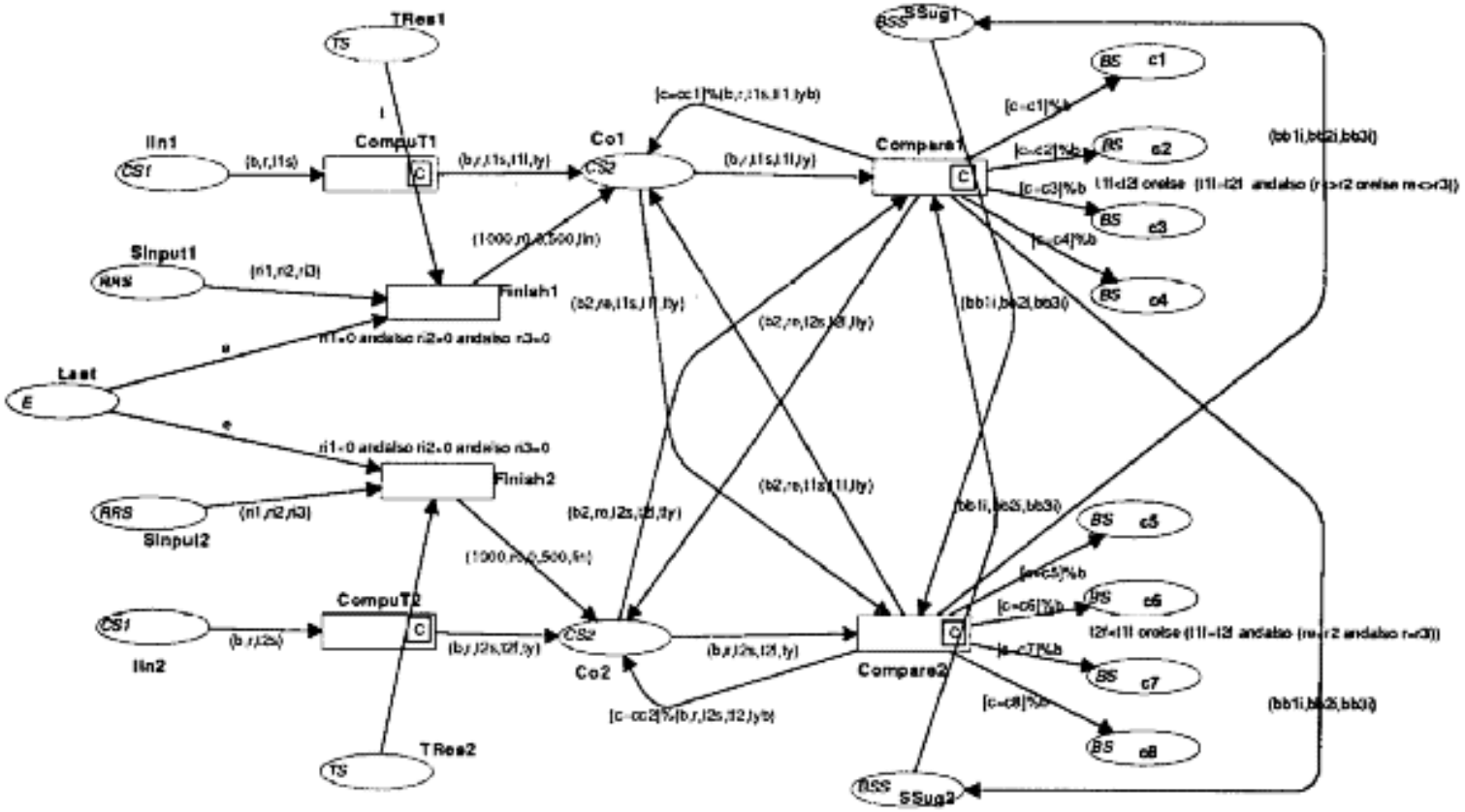
Method for goal: move to the unit task location
  Step 1. Get location of unit task from manuscript.
  Step 2. Decide: If unit task location on screen, return with goal
      accomplished.
  Step 3. Use scroll bar to advance text.
  Step 4. Goto 2.

Method for goal: move text
- **Step 1. Cut text**
- **Step 2. Paste text**
- **Step 3. Verify correct text moved.**
- **Step 4. Return with goal accomplished.**

Min, et. al., "Distributed GOMS: An extension of GOMS to Group Task"

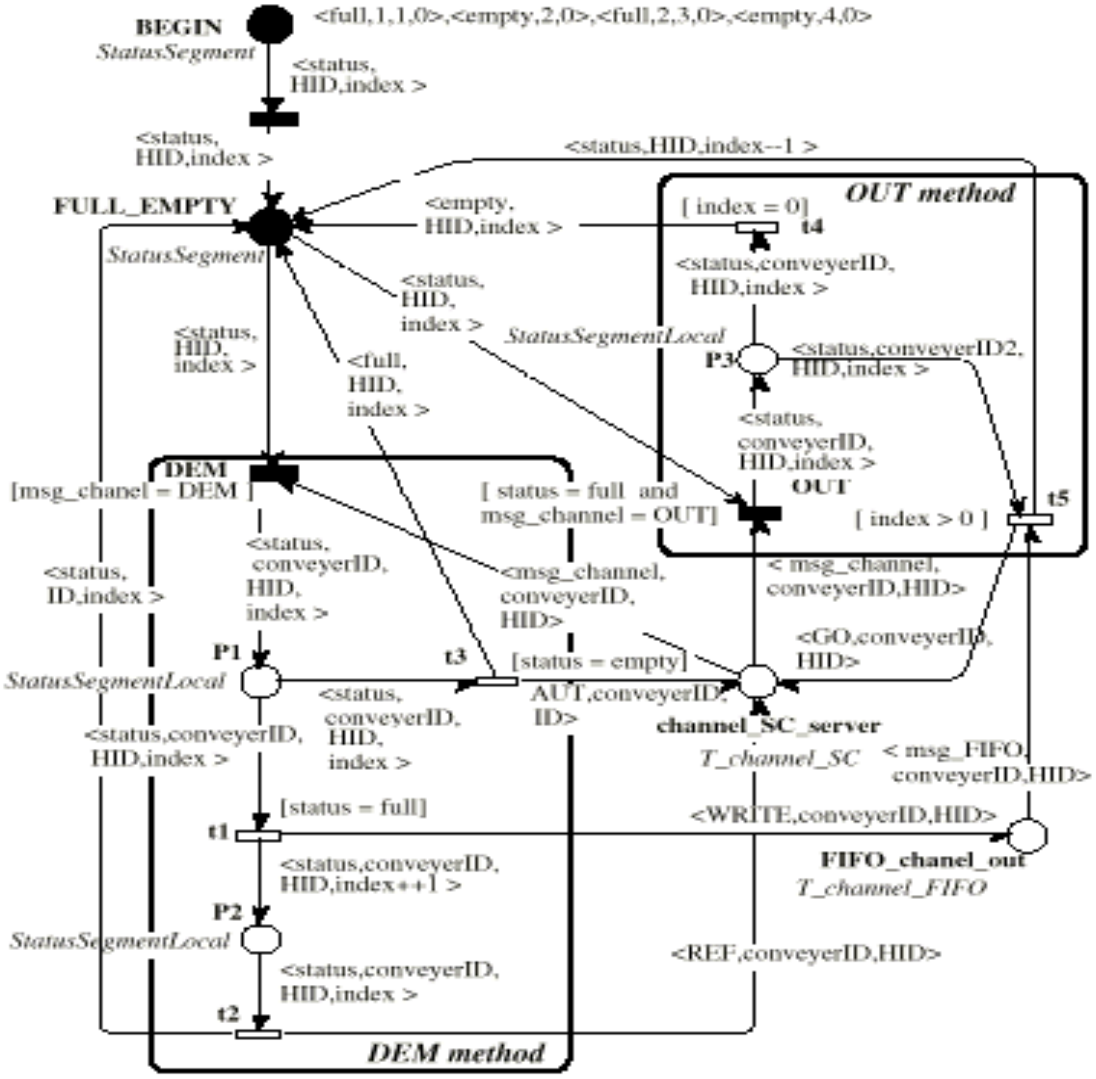
Kieras, "A Guide to GOMS Model Usability Evaluation using NGOMSL"

Colored Petri Nets



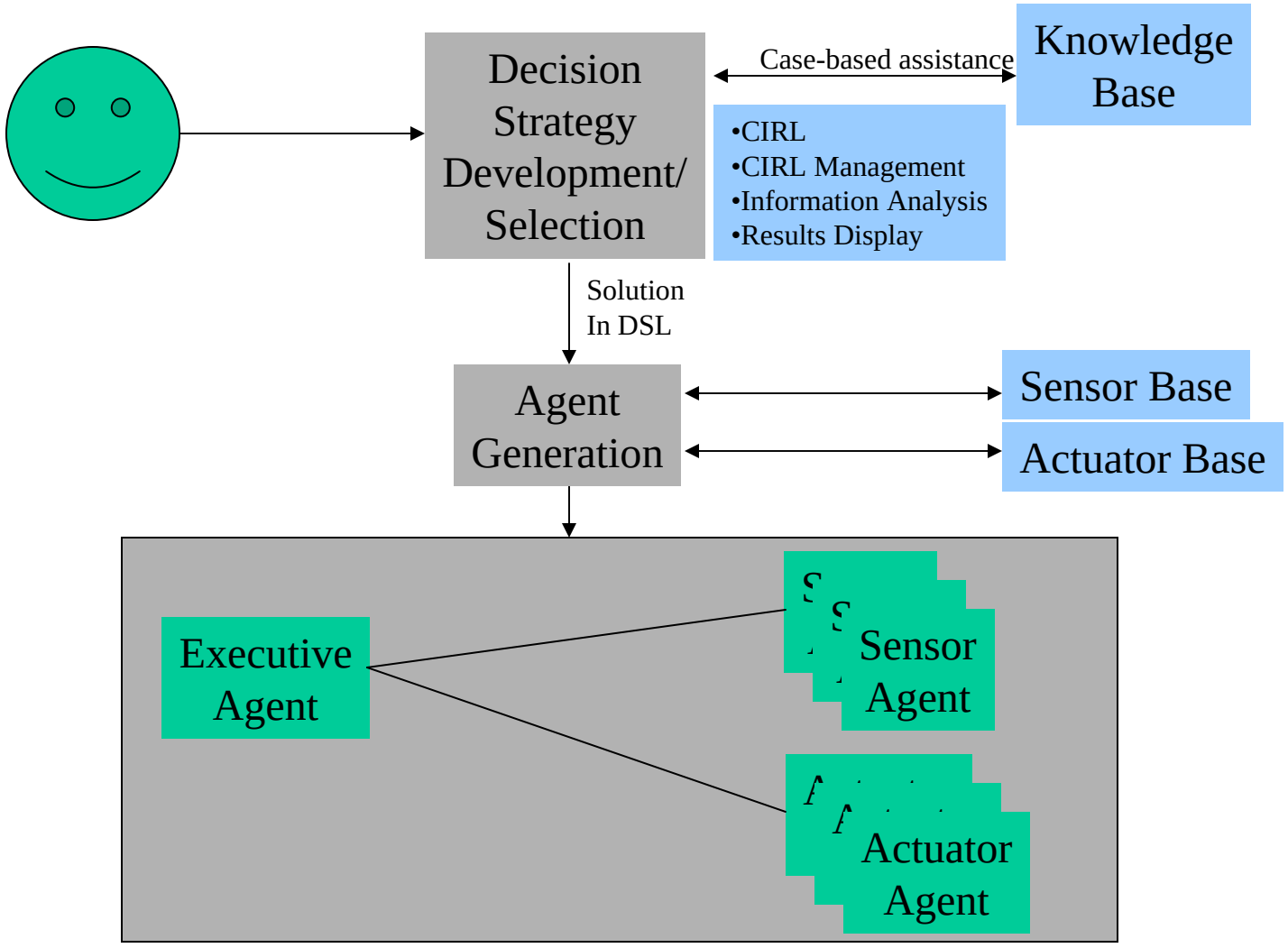
Lu, *A Colored Petri Net Model of Tactical Decision Making*

Petri Nets for Code Generation



F. Kordon, I. Mounier, E. Paviot-Adet, D. Regep, “Formal verification of embedded distributed systems in a prototyping approach”

GDSA


Decision Strategy Development/ Selection
Case-based assistance
Knowledge Base
•CIRL
•CIRL Management
•Information Analysis
•Results Display
Solution In DSL
Agent Generation
Sensor Base
Actuator Base
Executive Agent
Sensor Agent
Actuator Agent

Domain Specific Language

- Based on Deterministic Timed Hierarchical Colored Petri Nets. Adds semantic content to the places, transitions, and edges relative to decision support agents.
  - Interactions with infrastructure
  - Use of sensors and actuators
  - Information item and list management strategies
  - Analysis steps
  - Result display
- Initial level is based on the level of reusable sensor and actuator modules and the level of abstraction of associated information objects.

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Research Areas

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- Cognitive model adaptation for decision strategy description for agent use and generation
  - Critical Information Requirements List
  - CIRL management criteria
  - Information analysis method
  - Result display
- Domain specific language for decision strategies
- Agent generation engine
- Sensor and Actuator reuse bases and semantic descriptions for selection
- User interface language for decision strategies
- Case-based reasoning support for decision strategy selection